Observations of Stratospheric Intrusions from the A-Train in 2006 During INTEX-B

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Presentation Motivations and Overview

Motivations

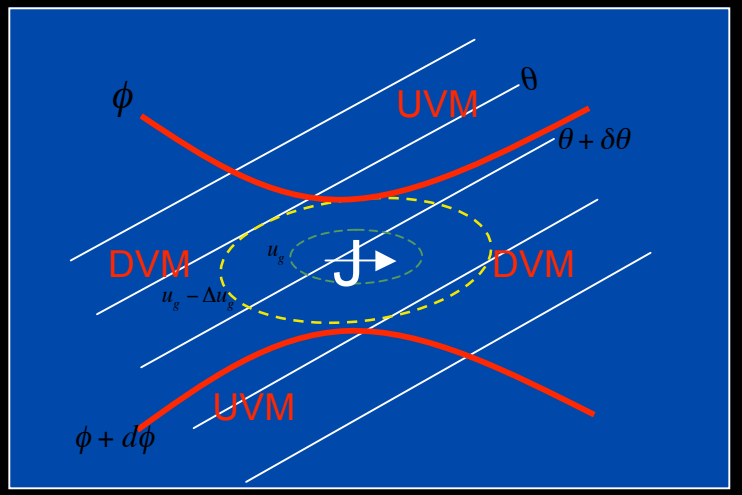
- To identify stratospheric intrusions in the upper troposphere and lower stratosphere using A-Train observations
- To investigate the 3-D structure of UTLS intrusions
- To compare A-Train observations with *in situ* measurements

Overview

- Use a combination of jet stream dynamics with atmospheric tracers to study UTLS
- Regional observations of a stratospheric intrusion event during April 2006 with AIRS ozone
- 3-D Look at UTLS using AIRS and TES ozone and water vapor
- Preliminary *in situ* comparisons with A-Train observations

Combination of Jet Stream Dynamics with Atmospheric Tracers

- The presence of thermally direct and indirect circulations near the jet contribute to the formation of upper level fronts.
- Jet streaks can assist in determining the location of downward vertical motion from the stratosphere along an upper level front.
- These regions are plausible locations for intrusions and tropospheric folds.
- We use NCEP Reanalysis wind vector data to map these jet streaks and find possible stratosphere to troposphere transport.



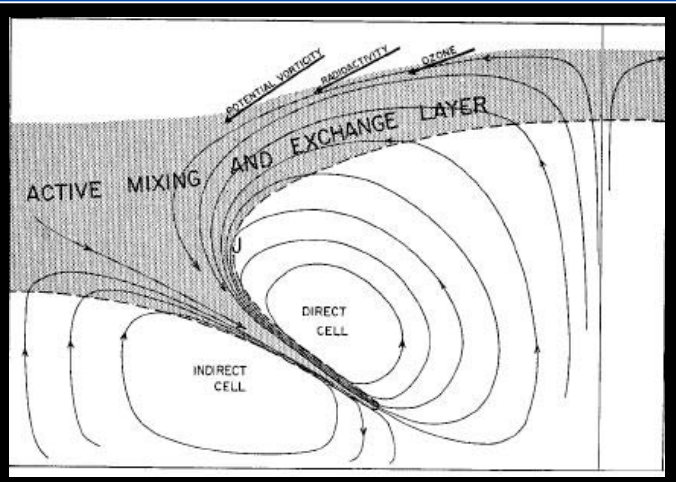
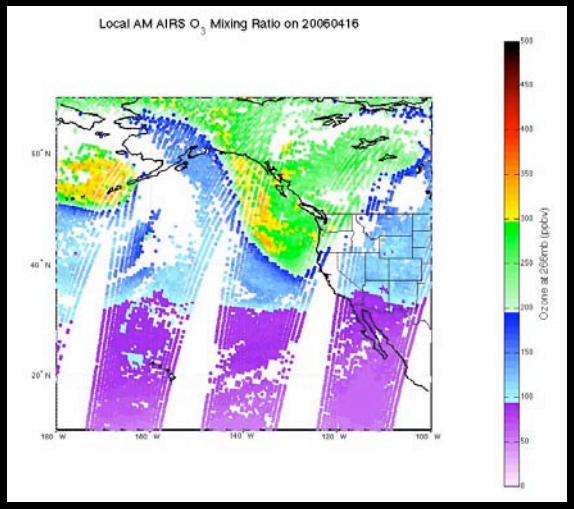
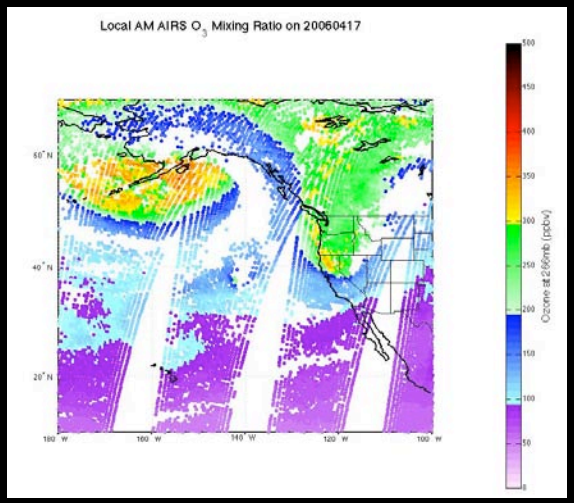
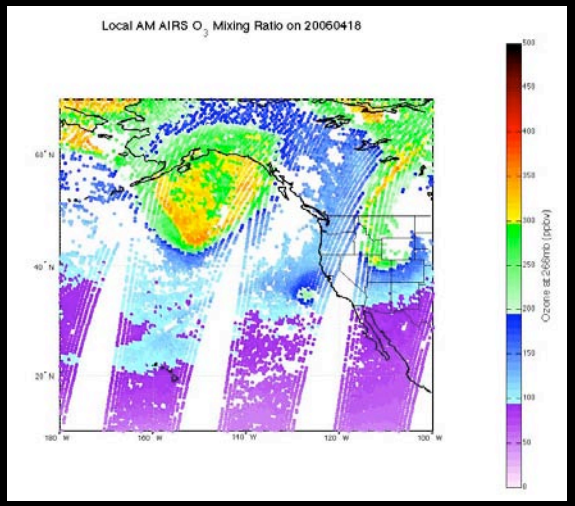


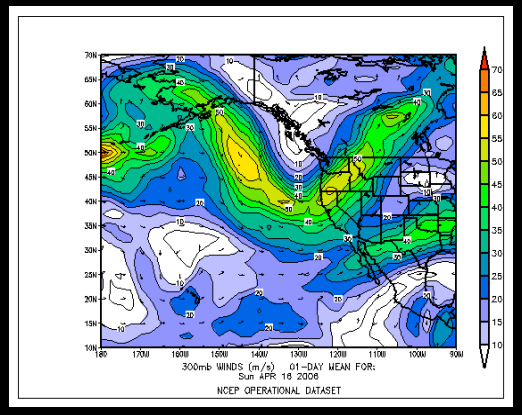
Figure taken from: Danielsen, 1968

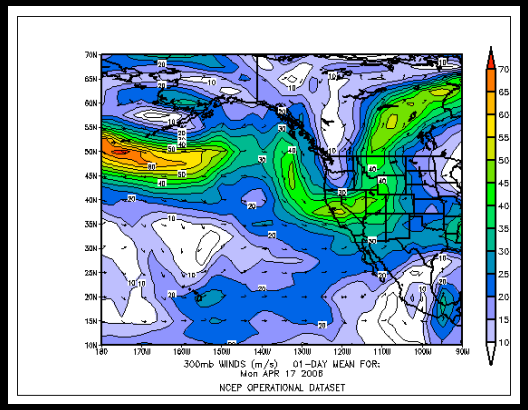
Observations During INTEX-B in April 2006

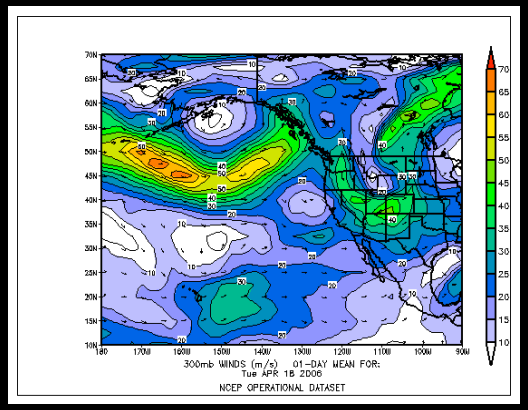




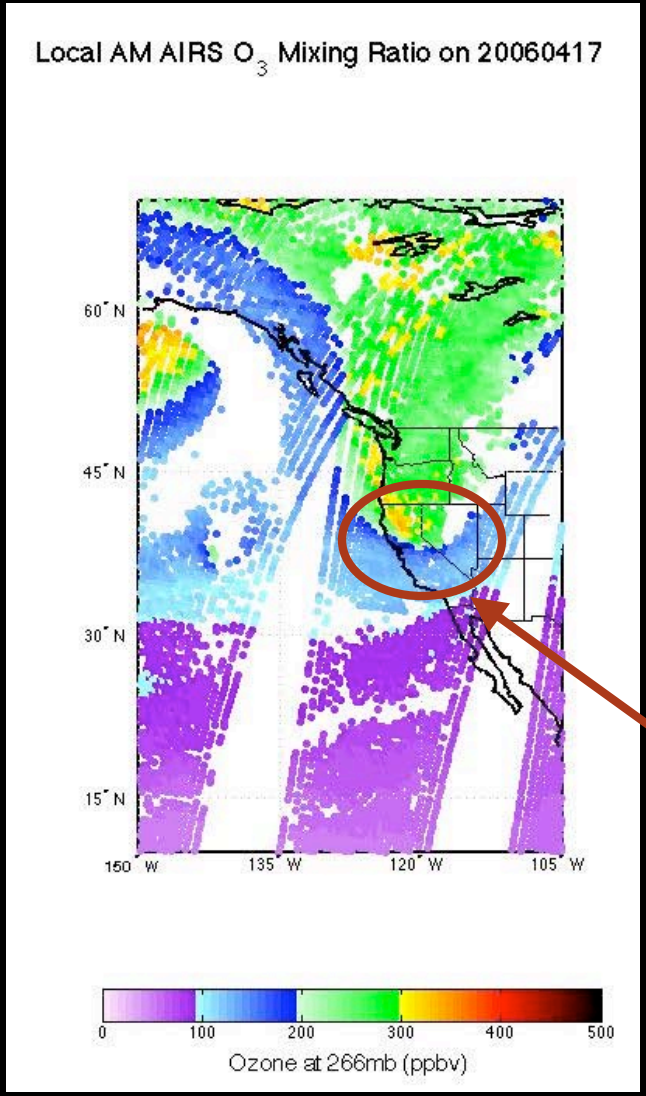








Investigation of 3D Structure of UTLS

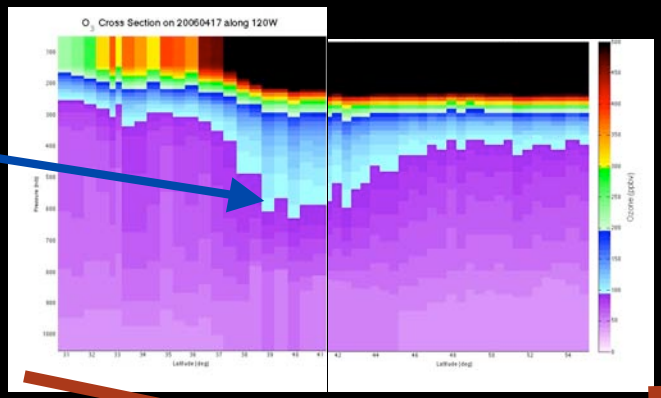


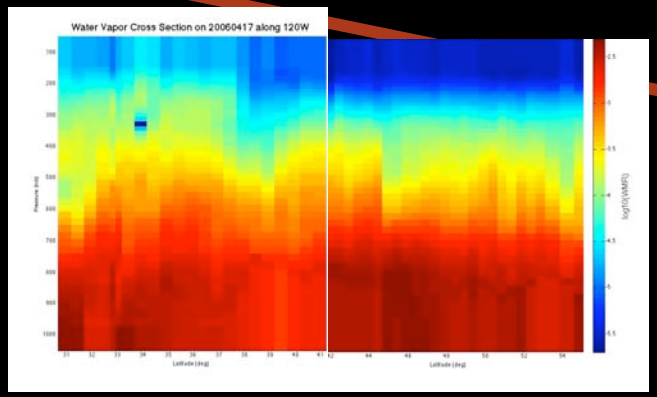
- To the left is a closer view of the high concentration of O_3 in northern CA as measured by AIRS at 266mb.
- There is a visible gradient in O_3 near the jet streak over CA.
- We expected to see a stratospheric intrusion or tropospheric fold on the northern side of the jet.

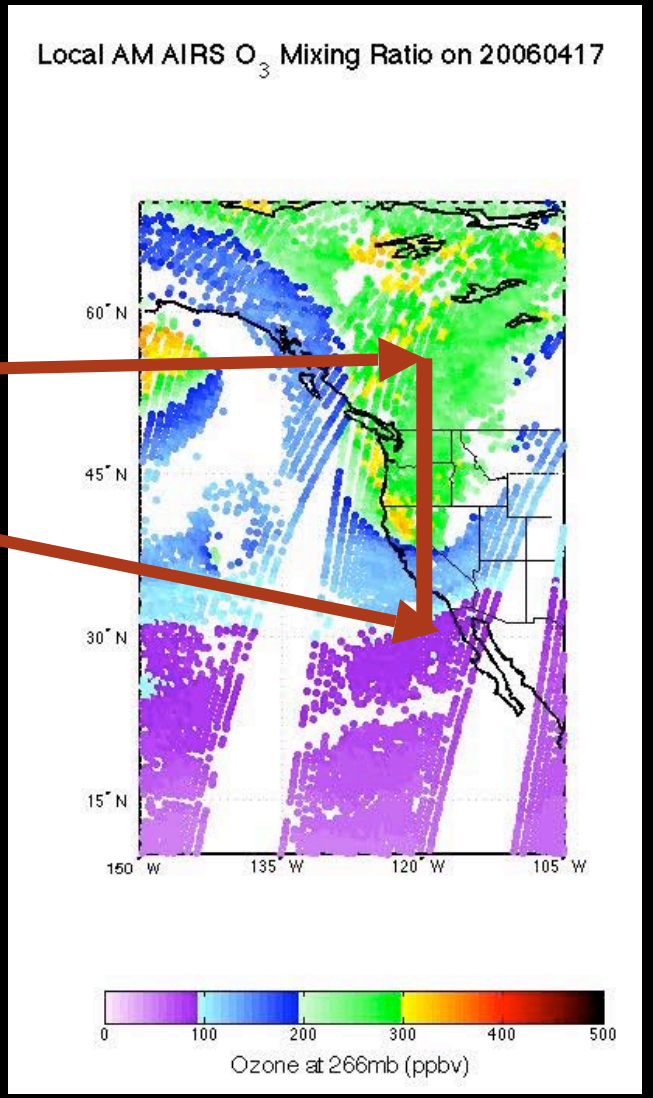
Possible region of UTLS transport

3D Structure of AIRS Ozone

AIRS sees possible intrusion on northern side of jet



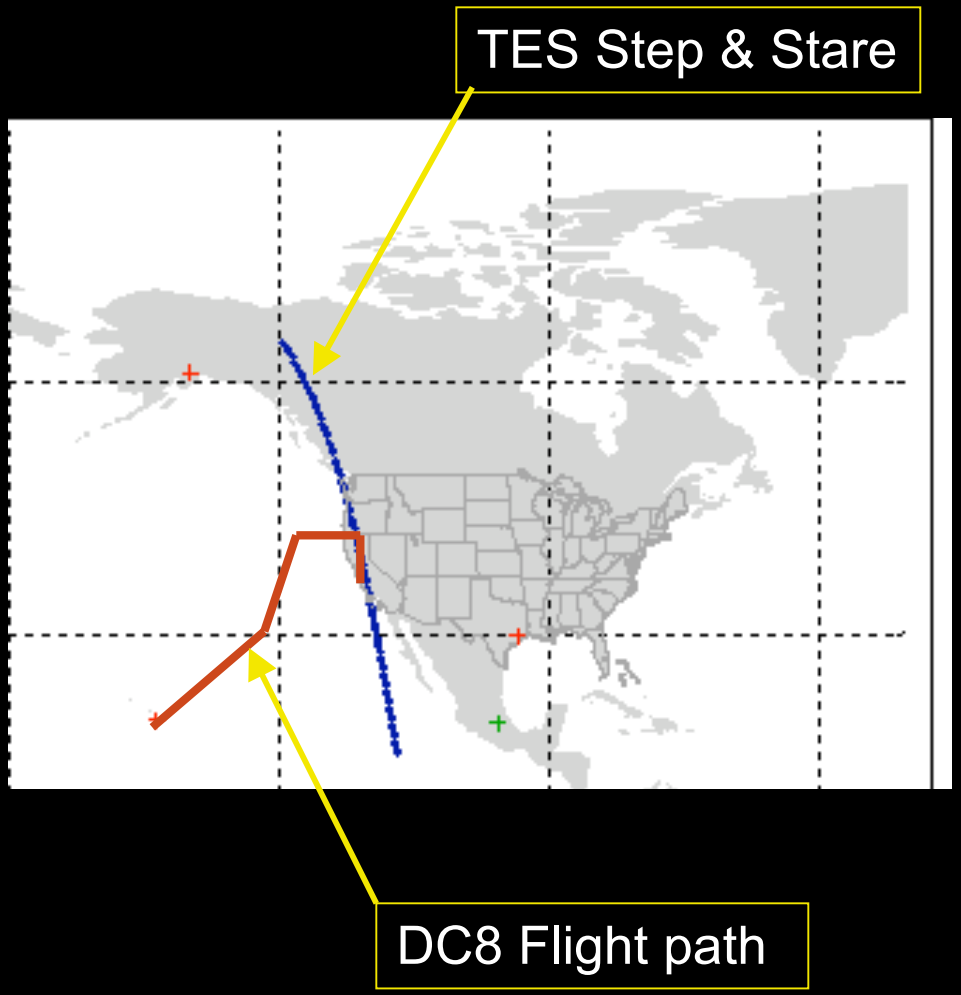




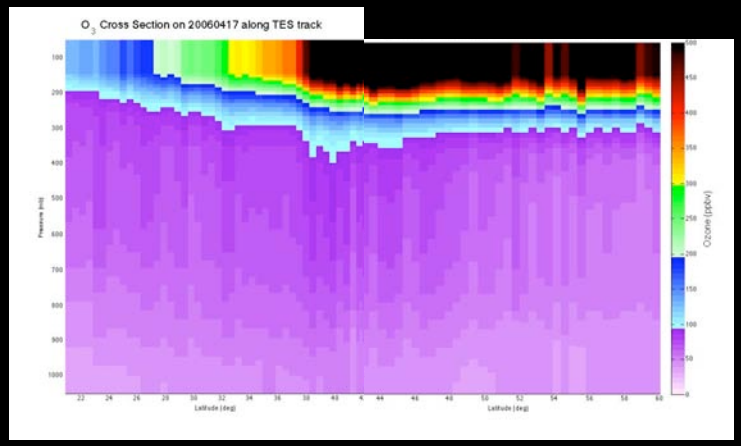
- We used cross-sections of O_3 and water vapor to trace stratospheric air crossing the tropopause.
- Above are O_3 and water vapor cross-sections from AIRS along 120W (straight through the jet streak).

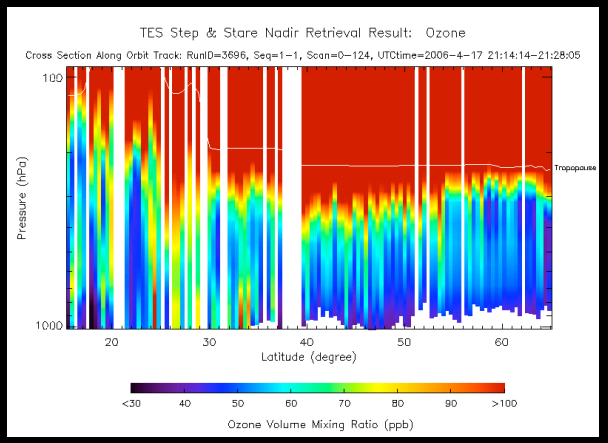
INTEX-B Field Exp. Comparison

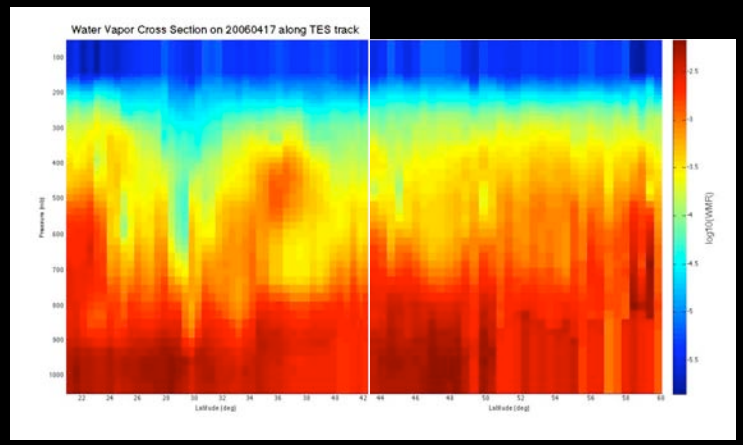
- The path in red shows a transit flight of the NASA DC8 aircraft during the INTEX-B field experiment
- TES Step and Stare Nadir cross-sections of O_3 and water vapor along the path indicated in blue are within 15 minutes of AIRS observations on April 17, 2006.
- For a brief period of time, the DC8, AIRS, and TES coincide with each other spatially and temporally

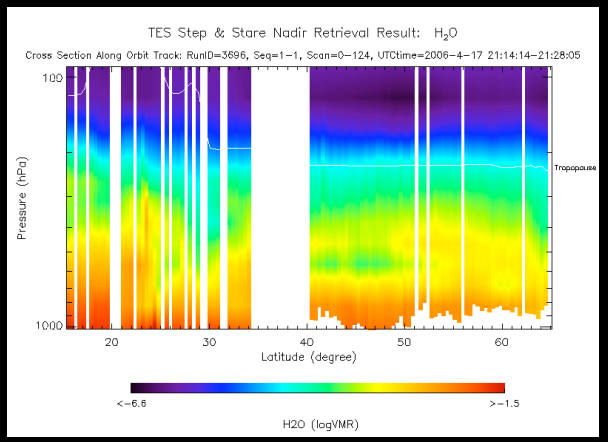


A-Train View of the West Coast on April 17, 2006





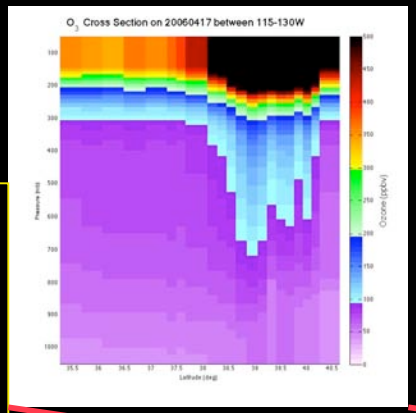


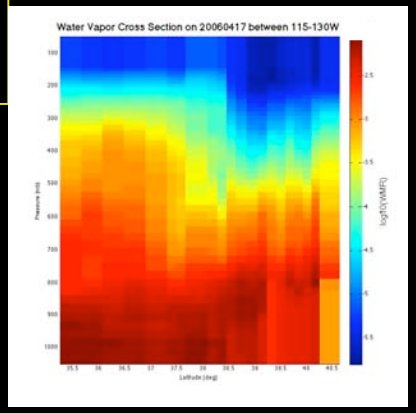


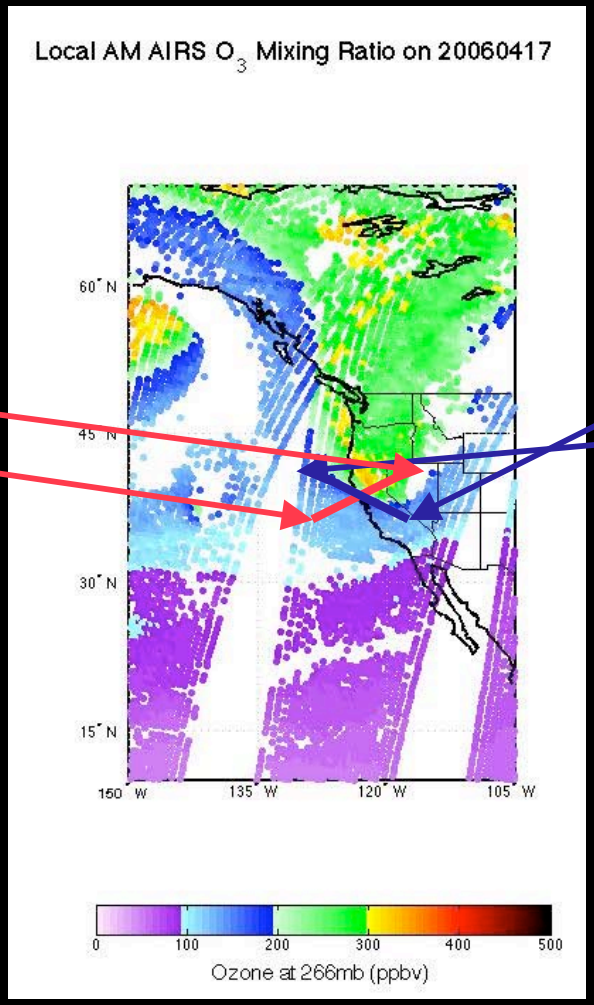
- By the afternoon on April 17, the front has passed to the right of the TES track. Neither instrument sees a large intrusion but still compares well for O_3.
- Both instruments see levels of 100ppbv of O_3 down to 400mb.

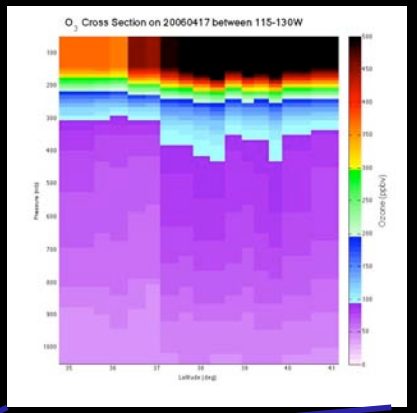
Another Three Dimensional View of the Stratospheric Intrusion on April 17

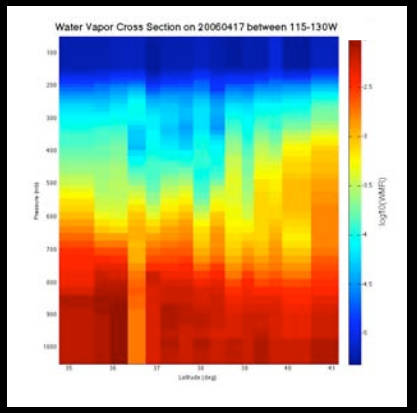
- We view the intrusion parallel to the jet axis at two different angles with AIRS, one of which corresponds spatially and temporally with a TES Step and Stare from a Global Survey in the AM.







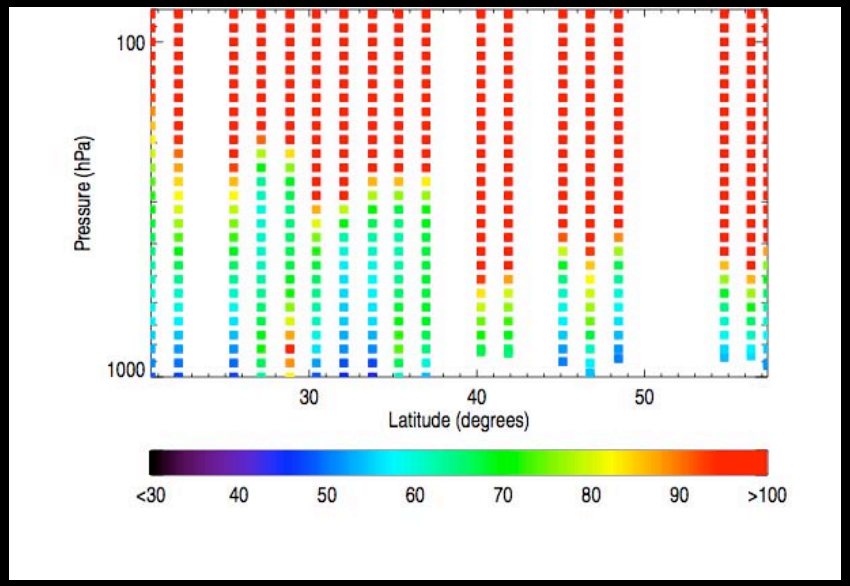


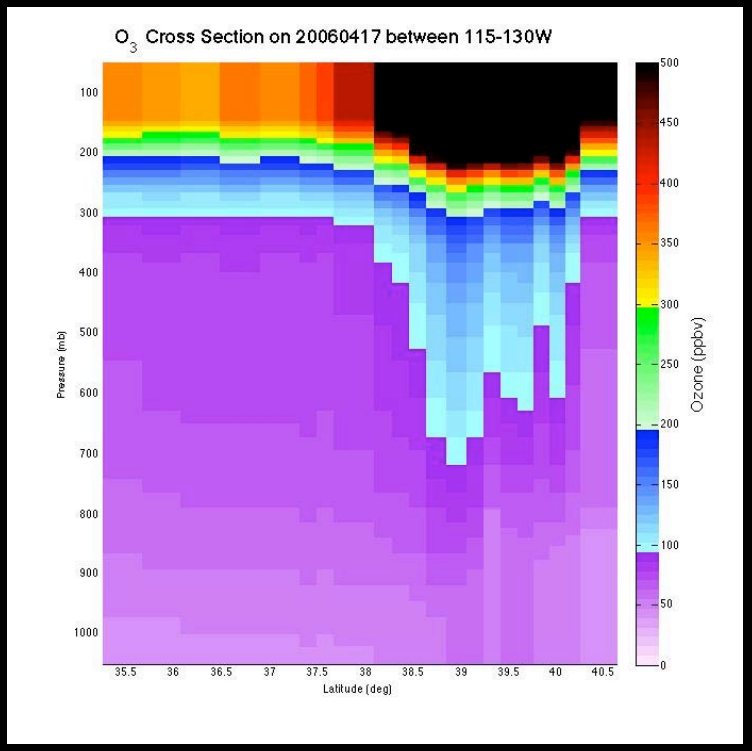


A-Train View of Stratospheric Intrusion on April 17

TES Step and Stare

April 17, 2006





- Above we view the intrusion parallel to the jet axis at an angle which corresponds spatially and temporally with a TES Step and Stare. This TES plot is only preliminary, however both AIRS and TES see O_3 levels >100 ppbv down to at least 600mb.

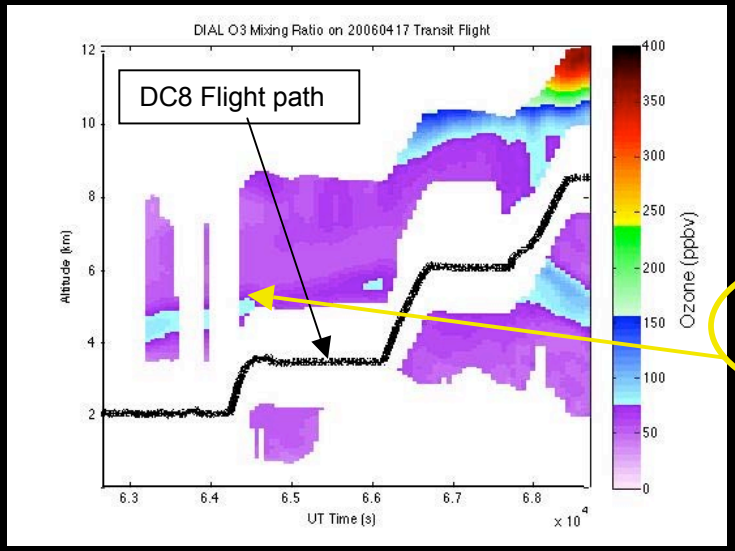
- This is exactly what we were hoping to see with both instruments. Now we can compare our results with in situ data.

In Situ Comparisons with A-Train on April 17

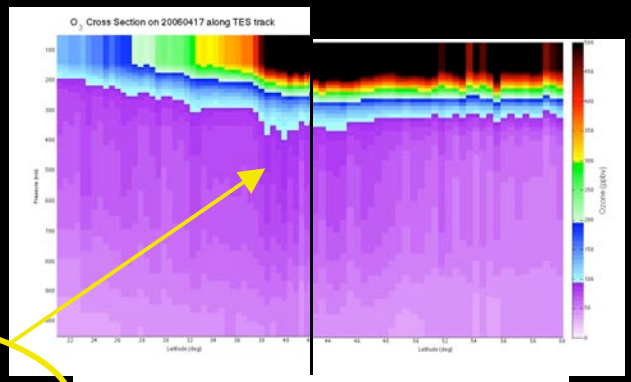
- The NASA Langley Airborne Differential Absorption Lidar (DIAL) system makes measurements of O3 in UV range with two lasers and receives signals from above and below the plane.

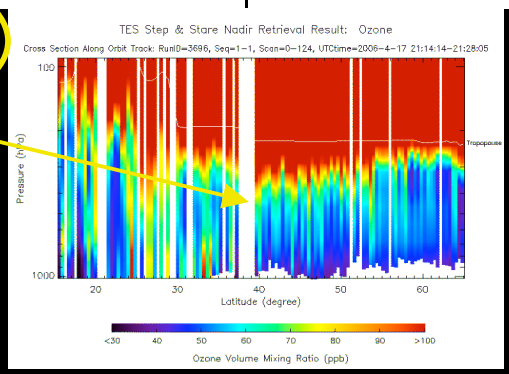
- During an INTEX-B transit flight from CA to HI, DIAL measured O3 profiles near 40 N.

- Comparing these coincidentally with AIRS and TES, we see similar features near the jet core which is the portion of the flight which is shown below.



40N near jet core

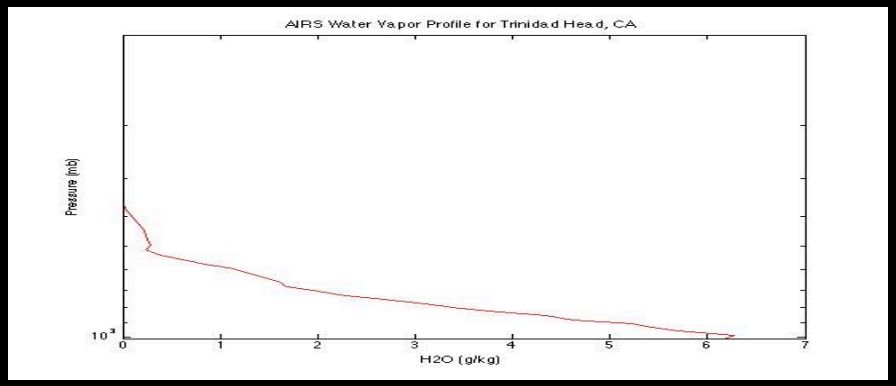


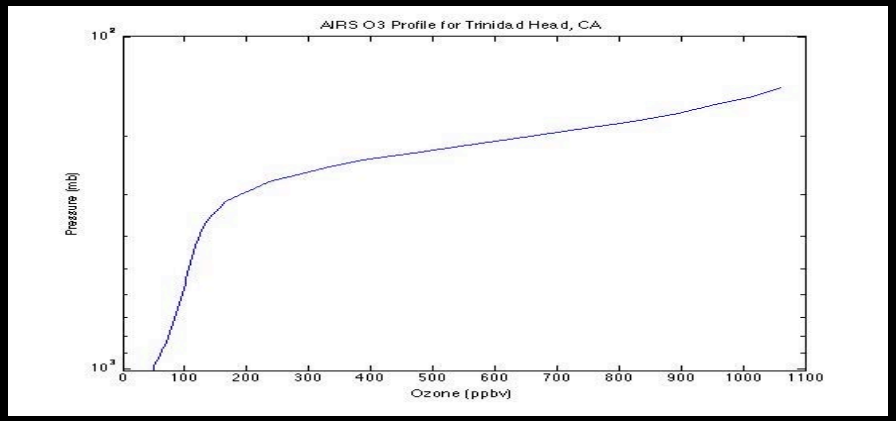


Ozonesonde Comparison with AIRS

- INTEX Ozonesonde Network Study (IONS) launched sondes near planned flight paths of the DC8 and other aircraft for coincident measurements of O_3 and water vapor.

- Figure below is a profile from one of these sondes launched at 41N and 124W which is Trinidad Head, CA. This is near the region of observed downward vertical motion from the stratosphere by AIRS and TES.





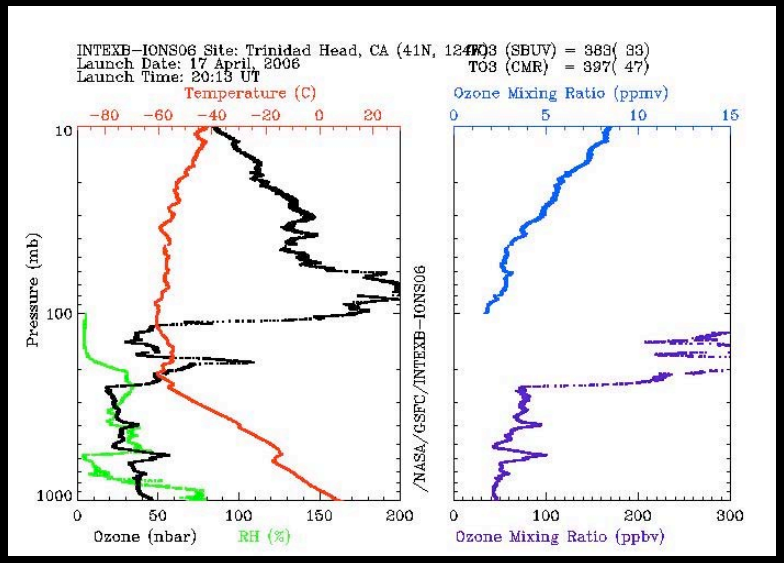


Figure from: http://croc.gsfc.nasa.gov/intexb/ions06).html

-For a first rough comparison, the figures above are water vapor and O_3 profiles from AIRS at Trinidad Head, CA.

- Next, we would like to see what TES sees in this area and examine these profiles closer too.

Conclusions and Future Work with AIRS and Other A-Train Instruments

Conclusions

- We can identify and map regions of downward vertical motion in UTLS with a combination of measurements of atmospheric tracers and dynamic parameters.
- We can use AIRS to study the 3-D structure of a stratospheric intrusion.
- In comparing AIRS with TES, we see qualitatively that they show similar vertical structure in ozone and water vapor.
- Preliminary comparisons with in situ data compare well with satellite data, but more sources are needed to be conclusive.

Future work

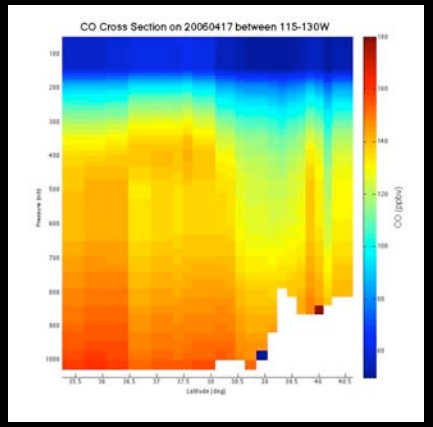
- We would like to expand our investigation of the UTLS further using other A-Train instruments like MLS, OMI, and HIRDLS.
- We will continue to verify what AIRS and the others see with in situ measurements.
- We also plan to incorporate potential vorticity into the 3-D structure of AIRS ozone profiles to identify STE.
- We hopefully will provide evidence to the debate whether STE is irreversible or not using AIRS ozone and water vapor products.

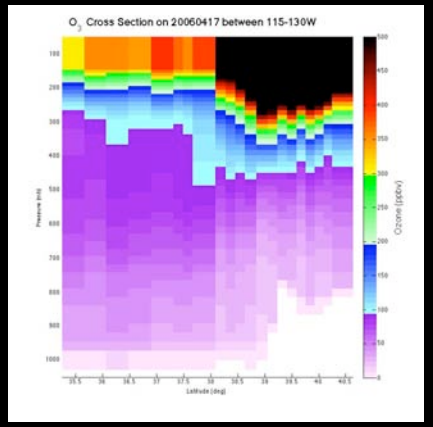
Acknowledgements

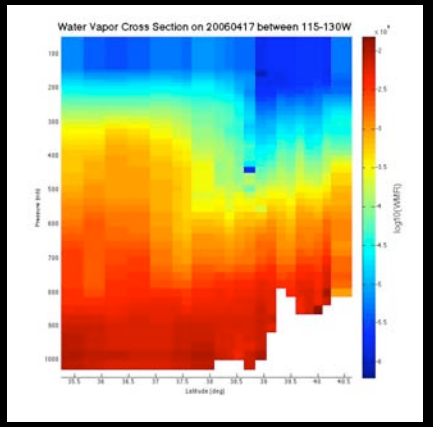
- Many thanks to IONS for making their data available to INTEX-B participants. (http://croc.gsfc.nasa.gov/intexb/ions06).html)
- Much appreciation to NOAA/ESRL Physical Sciences Division, Boulder Colorado and NCEP/NCAR Reanalysis 40-year Project for allowing me to use their data. (http://www.cdc.noaa.gov/)
- This research effort was supported through EOS NASA grants.

V4.2 vs. V5 AIRS Products on April 17

V4







V5